CLAIMS:

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1. A photon source comprising:

a quantum dot having a first confined energy level capable of being populated with an electron and a second confined energy level capable of being populated by a hole; and

supply means for supplying carriers to the said energy levels, wherein the supply means are configured to supply a predetermined number of carriers to at least one of the energy levels to allow recombination of a predetermined number of carriers in said quantum dot to emit at least one photon.

2. The photon source of claim 1, wherein the supply means are configured to repetitively supply a predetermined number of carriers at a predetermined time to the at least one energy level to allow emission of a predetermined number of photons at predetermined time intervals.

3. The photon source of claim 1, wherein the supply means are configured to repetitively supply a single carrier to the at least one energy level to allow emission of a single photon separated from each other by predetermined time intervals.

4. The photon source of claim 1, comprising a plurality of quantum dots.

5. The photon source of claim 1, wherein the supply means comprises incident radiation configured to excite a predetermined number of electrons and/or holes into the first and second energy levels respectively.

6. The photon source of claim 5, wherein the supply means comprises pulsed radiation.

7. The photon source of claim 6, wherein the pulse has a duration which is less than the relaxation time of a carrier which it excites in the quantum dot.

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8. The photon source of claim 6, wherein the time between leading edges of successive pulses is greater than the recombination time of and electron and hole in the quantum dot.

9. The photon source of claim 7, wherein the time between leading edges of successive pulses is greater than the recombination time of and electron and hole in the quantum dot.

10. The photon source according to claim 5, wherein the incident radiation has an energy which is substantially equal to that of the quantum dot transition energy.

11. The photon source according to claim 5, wherein the said incident radiation has a predetermined polarisation.

12. The photon source of claim 1, wherein the supply means comprises modulation means configured to vary the transition energy of the quantum dot.

13. The photon source of claim 12, wherein the modulation means comprises an AC voltage applied to vary the electric field across said dot.

14. The photon source of claim 12, wherein the modulation means comprise means to vary the carrier density within the source.

15. The photon source of claim 12, wherein the modulation means comprises means to vary the magnitude of a field applied to the said quantum dot.

16. The photon source of claim 1, wherein the supply means comprises a doped barrier layer provided to supply carriers to one of said energy levels.

17. The photon source of claim 15, wherein the supply means comprises means to electrically inject a predetermined number of carriers into the other of said energy levels.

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18. The photon source according to claim 16, wherein the carriers are injected into the other of said energy levels at the energy of said other energy level.

19. The photon source of claim 1, wherein the source has an output surface through which the emitted photons are collected, the source further comprising coupling means for coupling the emitted photons to a fibre optic cable.

20. The photon source of claim 1, wherein the source has an output surface through which the emitted photons are collected and comprises an anti-reflection coating located on said output surface.

21. The photon source of claim 1, wherein the source further comprises a lens for collecting emitted photons.

22. The photon source of claim 1, wherein the source comprises a mirror cavity having a mirror located on opposing sides of said quantum dot.

23. The photon source of claim 22, wherein the source has an output surface through which the emitted photons are collected and said mirror closest to said output surface is partially reflective such that it can transmit the emitted photons.

24. The photon source of claim 22, wherein the energy of the cavity mode for said mirror cavity is substantially equal to that of the emitted photons.

25. The photon source of claim 22, wherein the distance between the two mirrors L_{cav} bounding the cavity is defined by the equation:

$$L_{cav} = \frac{m\lambda}{2n_{cav}};$$

where λ is the wavelength of the emitted photons,
m is an integer and n_{cav} is the refractive index of the cavity.

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26. The photon source of claim 22, wherein the spectral band-pass of the cavity is substantially equal to the spectral width of the radiation emitted from the dot in the absence of a cavity.

27. The photon source of claim 22, wherein the quantum dot is positioned at an anti-node of the standing wave pattern caused by said mirrors.

28. The photon source of claim 22, wherein at least one of the mirrors is a Bragg mirror comprising a plurality of alternating layers wherein each layer satisfies the relation

$$nt = \frac{\lambda}{4}$$

wherein λ is the wavelength of the emitted photons, n and t are the refractive index and thickness respectively of a layer within the mirror.

29. The photon source of claim 22, wherein a mirror comprises a metal layer and a phase matching layer.

30. The photon source according to claim 1, wherein the source further comprises an optic fibre cable for collecting the emitted light.

31. A photon source according to claim 29, wherein the wavelength of the fibre optic cable is substantially equally to the wavelength of the cavity mode.

32. The photon source of claim 30, wherein the optical fibre has a non-reflective coating.

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33. The photon source of claim 1, wherein the source further comprises a filter configured to select emitted photons of a particular energy.

34. The photon source of claim 1, wherein the source further comprises a polariser configured to select emitted photons of a particular polarisation.

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35. A method of fabricating a photon source, the method comprising:

forming a quantum dot layer by growing a layer of a first material on a second material, wherein there is a variation in the lattice constants between the first material and the second material, the first material being deposited in a layer which is thin enough to form a plurality of quantum dots,

the method further comprising providing supply means for supplying carriers to the said energy levels, wherein the supply means are configured to supply a predetermined number of carriers to at least one of the energy levels in the quantum dots to allow recombination of a predetermined number of carriers in said quantum dot to emit at least one photon.

36. A photon source comprising:

a quantum dot having a first confined energy level capable of being populated with an electron and a second confined energy level capable of being populated by a hole; and

a supply device supplying carriers to the said energy levels, wherein the supply device is configured to supply a predetermined number of carriers to at least one of the energy levels to allow recombination of a predetermined number of carriers in said quantum dot to emit at least one photon.

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37. A method of operating a photon source, wherein the photon source comprises:

a quantum dot having a first confined energy level capable of being populated with an electron and a second confined energy level capabl of being populated by a hole; the method comprising:

supplying carriers to the said energy levels, such that a predetermined number of carriers are supplied to at least one of the energy levels to allow recombination of a predetermined number of carriers in said quantum dot to emit at least one photon.

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38. A method of fabricating a photon source, the method comprising:

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forming a quantum dot layer by growing a layer of a first material on a second material, wherein there is a variation in the lattice constants between the first material and the second material, the first material being deposited in a layer which is thin enough to form a plurality of quantum dots,

the method further comprising providing a supply device supplying carriers to the said energy levels, such that a predetermined number of carriers are supplied to at least one of the energy levels in the quantum dots to allow recombination of a predetermined number of carriers in said quantum dot to emit at least one photon.

39. A photon source comprising:

an active layer having a low dimensional carrier gas with an excess of carriers of a first type; and

tuning and injection means for varying the excess carrier concentration of carriers of the first type in the active layer and for injecting a carrier of a second type into the active layer such that radiative recombination can occur between the carrier of the second type and a carrier of the first type, wherein carriers of the second type have the opposite polarity to those of the first type.

40. The photon source of claim 39, wherein said active layer has a confined energy level capable of being populated with a carrier of a second type, and said injection and tuning means is capable of injecting a second type carrier at the energy of the confined energy level.

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41. The photon source of claim 40, further comprising a tunnel layer said tunnel layer being capable of supporting a low dimensional carrier gas having a confined energy state which is capable of being populated with a carrier of the second type, said tuning and injection means being capable of aligning the confined energy state of the tunnel layer with the confined energy state of the active layer.

42. The photon source of claim 41, wherein the tunnel layer comprises at least one quantum dot capable of confining a single carrier of the second conductivity in the confined energy state of the tunnel layer.

43. The photon source of claim 39, wherein the tuning and injection means are capable of varying the carrier concentration of excess carriers for a particular injection condition of a second type carrier.

44. The photon source of claim 43, wherein the tuning and injection means are configured to vary the excess carrier concentration of the active layer for a particular alignment of the said energy levels of the active and tunnel layer.

45. The photon source of claim 39, wherein said tuning and injection means comprise an ohmic contact provided to the active layer and a first gate provided to control the carrier concentration of said first carrier type in said active layer.

46. The photon source of claim 45, wherein the tuning and injection means comprises a second gate located on an opposing side of the active layer to the first gate.

47. The photon source of claim 39, wherein a first barrier layer is provided such that a second type carrier tunnels through the first barrier layer before it enters the active layer.

48. The photon source of claim 41, wherein a second barrier layer is located such that such that a second type carrier tunnels through the second barrier layer before it enters the tunnel layer.

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49. The photon source of claim 39, wherein the source further comprises a reservoir region comprising an excess of second type carriers.

50. The photon source of claim 49, wherein the tuning and injection means are configured to align the confined energy state of the tunnel layer with that of the energy of carriers of the second type in the reservoir.

51. The photon source of claim 39, wherein the tuning and injection means are configured to switch the source between a first tunnel state where the confined energy level of the tunnel layer is only aligned with the energy of second type carriers in the reservoir and a second state where the confined energy level of the tunnel layer is only aligned with the confined energy level of the active layer.

52. A photon source comprising:

an active layer having a low dimensional carrier gas with an excess of carriers of a first type; and

a tuning and injection device varying the excess carrier concentration of carriers of the first type in the active layer and for injecting a carrier of a second type into the active layer such that radiative recombination can occur between the carrier of the second type and a carrier of the first type, wherein carriers of the second type have the opposite polarity to those of the first type.

53. A method of operating a photon source, the photon source comprising:

an active layer having a low dimensional carrier gas with an excess of carriers of a first type; the method comprising:

varying the excess carrier concentration to maximise the radiative recombination rate and injecting a carrier of a second type into the active layer for radiative

recombination with a carrier of the first type; wherein carriers of the second type have the opposite polarity to those of the first type.

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54. The method of operating a photon source of claim 17, wherein the step of varying the excess carrier concentration comprises the step of maximising the excess carrier concentration of the active layer.

55. The method of operating a photon source of claim 17, wherein the step of varying the excess carrier concentration comprises the step of biasing a gate with respect to said active layer.